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# FARMERS' BULLETIN



WASHINGTON, D. C.

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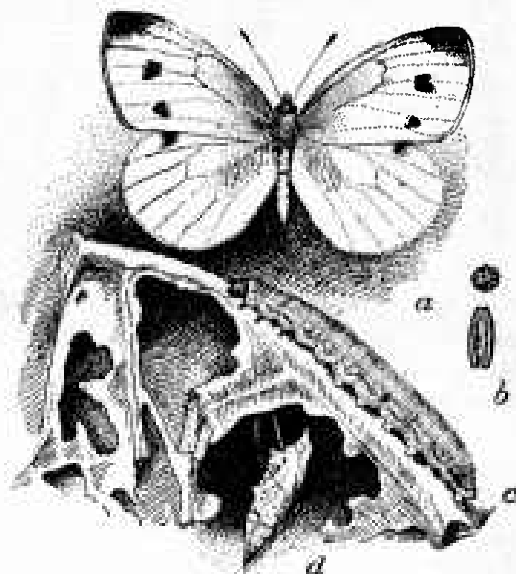
Contribution from the Bureau of Entomology, L. O. Howard, Chief.

## THE COMMON CABBAGE WORM.<sup>1</sup>

By F. H. CHITTENDEN, *Entomologist in Charge of Truck-Crop and Stored-Product Insect Investigations.*

### INTRODUCTORY.

The most destructive of the many insect and other enemies of cabbage and related crops over the United States generally is the larva or caterpillar of the imported cabbage butterfly (figs. 1, 2), sometimes called the white butterfly or rape butterfly, a familiar object to nearly everyone. This caterpillar, the imported cabbage worm, is well known to farmers throughout this country and in the Old World as well, and the butterfly is generally recognized by the farmer as the parent of the "worms."



### DESCRIPTIVE.

#### THE CATERPILLAR.

This cabbage worm is velvety green, about the same color as the cabbage on which it feeds. There is a faint yellow stripe down the middle of the back and a row of yellow spots along each side in line with the spiracles or breathing

FIG. 1.—The common cabbage worm (*Pontia rapae*): a, Female butterfly; b, above, egg as seen from above; below, egg as seen from side; c, larva, or "worm," in natural position on cabbage leaf; d, suspended chrysalis. a, c, d, slightly enlarged; b, more enlarged. (Author's illustration.)

<sup>1</sup> *Pontia rapae* L.; order Lepidoptera, family Pieridae.

NOTE.—This bulletin is intended to assist cabbage growers to control one of their most troublesome pests.

pores. The surface of the body, if viewed through an ordinary hand lens, is seen to be somewhat rough and finely dotted with small black spots. It measures, when full grown, about an inch and a fourth in length, presenting the appearance shown in figure 1, *c*. It differs from the cabbage looper,<sup>1</sup> another caterpillar found on such crops, in having five pairs of prolegs (unjointed hind legs) instead of four.

#### THE BUTTERFLY.

The butterfly (fig. 2) has a wing expanse of nearly 2 inches. It is white, marked with black near the tips of the forewings, as shown in figure 1, *a*, which represents the female. In the female there are two conspicuous black spots on each forewing, whereas the male (fig. 2) has only one. Each sex has a corresponding smaller black spot at the front edge of the hind wing. The body of the female is

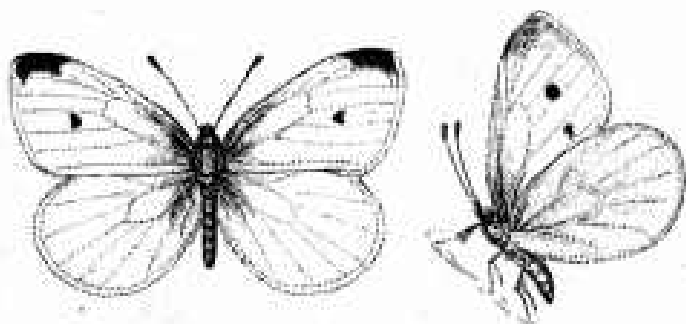


FIG. 2.—The common cabbage butterfly: Male, wings spread at left, wings folded at right. Somewhat enlarged. (Author's illustration.)

whitish, but that of the male is usually darker above. The male is generally the smaller. The underside of the hind wing is a uniform straw yellow of satiny aspect, and there are generally two black spots showing through in both sexes.

#### THE EGG.

The eggs are turnip-shaped, pale yellowish, and strongly ribbed (fig. 1, *b*), and may be seen readily with the unaided eye. They are deposited singly, usually on the underside of the outer leaves of cabbage and their other food plants.

#### THE CHRYSALIS.

When the caterpillar or "worm" becomes full-grown it attaches itself to a cabbage leaf or other near-by object by means of a thread-like girdle of silk, and often within the same day transforms to the chrysalis (fig. 1, *d*). The chrysalis is of variable color, being

<sup>1</sup> *Autographa brassicae* Riley.

influenced in this respect by the object upon which it is fastened. The color thus varies through dirty gray to yellow, green, and dark gray. The length of the chrysalis is a little less than three-fourths of an inch.

### NATURE OF INJURY.

This cabbage worm has been rightly termed the bane of the cabbage grower and the dread of every careful cook and housewife. It begins work early in the season; the principal damage is therefore to young plants (fig. 3), and accrues through the necessity of replanting, with attendant increase in cost of production, due to additional labor, cost of stock, and delay in getting the early or better prices in the market. After riddling the outer leaves, which remain afterwards



Fig. 3.—Cabbage seedlings grown in cold frames, showing injury by common cabbage worm. This necessitates replanting and additional labor, and causes delay in getting cabbage on the early market. (Original.)

attached to the stalk, the caterpillar attacks the tender inner leaves as they form, frequently secreting itself in the immature heads, where it is difficult to reach it with insecticides, and rendering the cabbage unfit for food because of the abundant dark green excrement which it deposits. As a result, cabbages before being sent to market must be examined carefully and the damaged leaves removed. Before cooking it is frequently necessary to tear the heads apart to insure that no disgusting worms are concealed within, and even after the vegetable is prepared for the table there is danger of an admixture of animal matter with the vegetable food. In cool weather the caterpillar often feeds freely exposed on the surface of the leaves in the sunshine.

Frequently the caterpillar bores into the center of the cabbage, attacking what is commonly known as the "heart," and then the entire head is worthless for market. Figure 4 illustrates this form of injury. Seedling cabbage grown in cold frames is also often damaged. Injury of this nature may be very serious, many of the plants being a complete loss, while the remainder make poor growth. Figure 5 illustrates an unusual form of damage in which the insects occur in such numbers as to congregate on a single leaf and ruin it



FIG. 4.—Cabbage showing severe injury by the common cabbage worm. This cabbage plant will never make a marketable head. (Original.)

in a very short time. This illustrates complete defoliation, and also is an indication of the sluggish habits of the larvæ during resting periods.

As early as 1869, when this cabbage worm was confined to limited areas in Canada, New England, and New York, it did great damage. At St. Albans Bay, Vt., in that year it caused the total destruction of a crop of 3,000 cabbage plants. The worms made their appearance

about the 1st of September, and there were from 10 to 50 on a head. The Abbé Provancher estimated the same year a loss of \$240,000 in the vicinity of Quebec alone. One farmer near Montreal lost in a single season over 12,000 heads of cabbage. The following year in some places about New York City, where the insect had appeared only the year before, the entire crop of cabbage and cauliflower was destroyed. The loss in this case was estimated at half a million dollars.

Owing to the fact that during recent years arsenicals have been very generally used to control the cabbage worm, there are now few instances in any part of this country of the total destruction of crops of cabbages as was formerly often the case. Nevertheless a conservative estimate would place the present annual loss from this pest to cabbages alone (not including cauliflower and other related crops) at \$1,300,000, or one-tenth of the entire crop.

#### ORIGIN, SPREAD, AND PRESENT DISTRIBUTION.

The imported cabbage butterfly was introduced from Europe, and was first recognized from a capture at Quebec, Canada, in 1860. It was not seen again until two years later, in the same locality. After a lapse of several years it was reported at intervals from other portions of Canada. In 1865 its first appearance in the United States was noted in Maine; the following



FIG. 5.—Cabbage leaf completely defoliated by seven common cabbage worms. Slightly enlarged. (Original.)

the following

year, in northern New Hampshire and Vermont. In 1868 it had reached New York, and soon thereafter began to attract attention in new localities. In 1875 it appeared in Cleveland, Ohio, and two years later in Illinois. In 1880 it had penetrated southward to the Gulf States. This distribution has continued until now the species is known in practically every State in the Union. It appears to

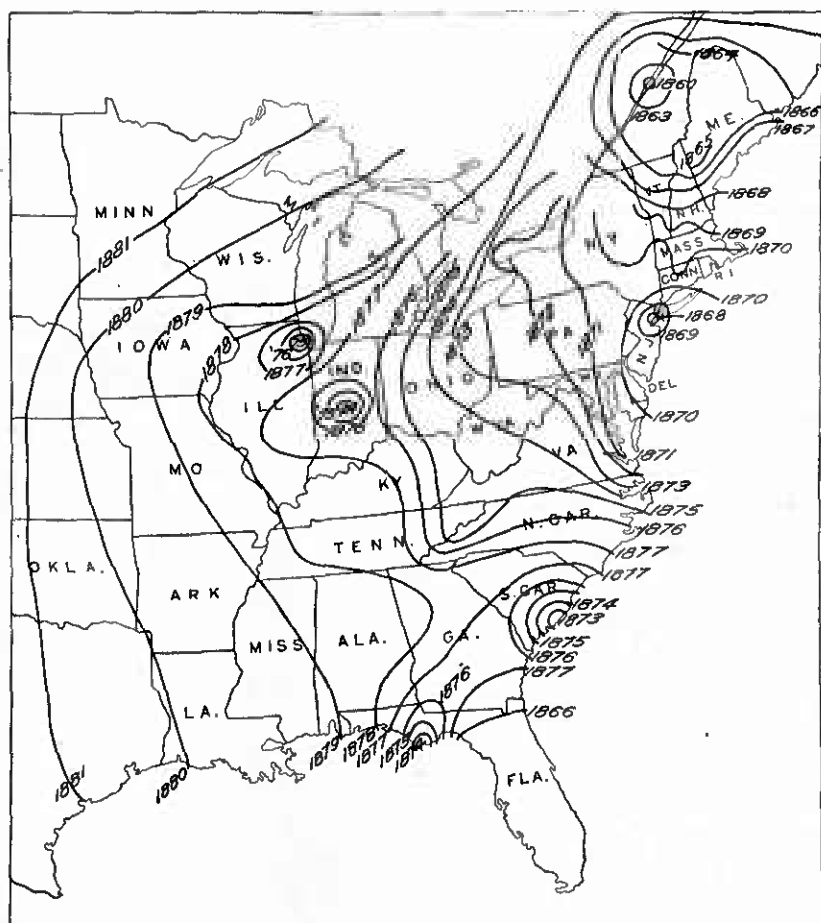


FIG. 6.—Map showing spread of common cabbage butterfly from 1860 to 1881. (Adapted from Scudder.)

favor no particular part of the country, being as destructive in the Gulf region as in Canada and New England. In the Western Hemisphere this butterfly ranges from the Atlantic to the Pacific, in most localities between the thirtieth and sixtieth degrees of latitude.

The accompanying map (fig. 6) shows approximately how this species has spread, chiefly by flight, according to the opinion of the

late Dr. S. H. Scudder, who was the highest authority on American butterflies. The westward spread has not been followed carefully.

### FOOD HABITS.

The imported cabbage worm feeds on all forms of cruciferous plants, is particularly fond of cabbage and cauliflower, and is somewhat less destructive to turnip, kale, collards, radish, mustard, and horseradish. It also does considerable damage to ornamental plants, such as nasturtium, mignonette, sweet alyssum, the spider plant (*Cleome*), and exceptionally to lettuce.

The butterflies sip the nectar of flowers of various kinds and may be seen at any time hovering over them. They are especially fond of the white blossoms of crucifers, and of the flowers of white aster, lavender, purple heliotrope, and thistle. Like other butterflies, this species is active by day, and is on the wing from early morning until near dusk. It is a comparatively slow, tireless flyer, being capable of extended flight for long distances. The butterflies sometimes congregate in immense swarms, as has occurred frequently when they have emigrated from the continent of Europe to England, and their occurrence in midocean has been recorded.

### LIFE HISTORY.

The butterflies appear on warm sunny days as early as March, even in the Northern States, and thereafter may be seen flying until after several severe frosts in October. In the Gulf region they occur throughout the season.

Pairing and egg laying begin within a day or two after the adult issues from the chrysalis. The duration of the different stages naturally varies with temperature conditions, that of the egg period being from 4 to 8 days.

The caterpillar eats voraciously and grows rapidly, attaining maturity in from 10 to 14 days after hatching. It molts four times; hence there are five distinct instars or substages, the first molt taking place, in the warmest weather, in about 2 days from the time of hatching, the second stage lasting from 2 to 3 days, the third and fourth from 1 to 2 days each, and the fifth from 4 to 5 days. The duration of the chrysalis stage is from 7 to 12 days during the summer time, but the last chrysalides formed in the more northern States remain in suspense during the winter and develop the following spring.

The life cycle occupies periods varying between 22 days and 5 to 6 weeks. Even in New England this species is credited with being triple brooded, but in the District of Columbia and vicinity



there must be one or more additional generations, with a possibility of at least six in the extreme South. The first generation develops on wild plants.

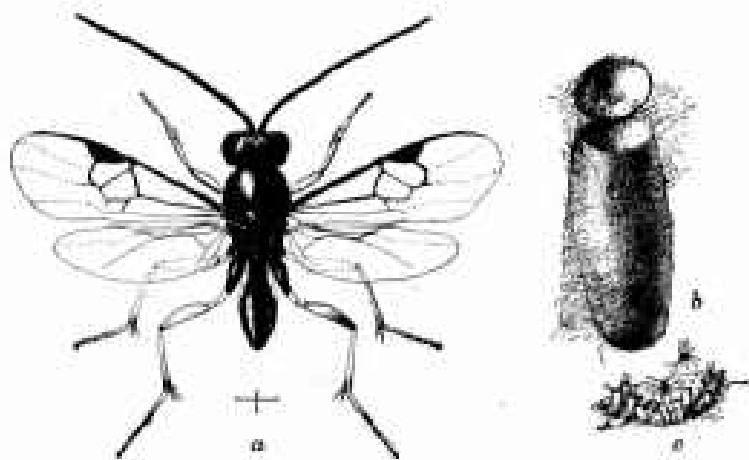


FIG. 7.—An ichneumon fly, *Apanteles glomeratus*, a valuable parasite of the common cabbage worm: a, Adult fly; b, cocoon; c, flies escaping from cocoons. a, b, Highly magnified; c, natural size. (Author's illustration.)

#### NATURAL ENEMIES.

Were it not for certain effective checks this species would be a still greater pest. The most important of its insect enemies are small parasites, all introductions from Europe. One of them, an ichneumon

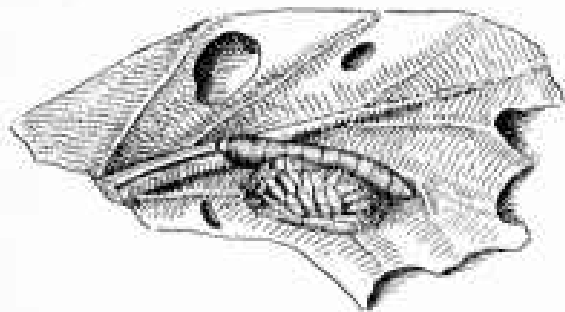


FIG. 8.—Parasitized cabbage worm, showing cocoon mass of ichneumon fly, *Apanteles glomeratus*, below. (Author's illustration.)

fly<sup>1</sup> (figs. 7, 8), was purposely imported in 1883 from England. During the autumn of 1904 this species held its host under complete control at Washington, D. C., killing every "worm" which came under the writer's observation. A larva which has been destroyed by this parasite is shown in figure 7, b, together with the parasite's cocoon. A minute chalcid fly<sup>2</sup> was present as a parasite of the beneficial ichneumon fly, but apparently did not destroy the effectiveness of the latter. Another chalcid fly<sup>3</sup> (fig. 9) which bears the same

<sup>1</sup> *Apanteles glomeratus* L.; order Hymenoptera, family Braconidae.

<sup>2</sup> *Tetrastichus microgasteri* Bouché.

<sup>3</sup> *Pteromalus puparum* L.

relation to the cabbage worm as does the ichneumon fly, and is therefore beneficial, was first noticed in this country in 1869, evidently having been imported with the host. The eggs of this species are deposited in the cabbage worm, which, while completing its transformation to pupa, dies, and the parasites issue from the latter.

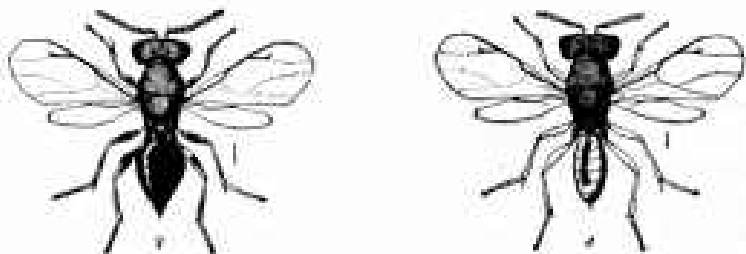


FIG. 9.—A chalcids fly, *Pteromalus puparum*, a parasite of the common cabbage worm: Female at left, male at right. Greatly enlarged. (Author's illustration.)

Wasps, particularly certain paper wasps<sup>1</sup> and related forms, are also of great service in reducing the numbers of this and other cabbage worms, appearing to prefer them to other prey.

The small, evil-smelling ambush-bug<sup>2</sup> (fig. 10) secretes itself in flowers, such as the thistle and goldenrod, and destroys numbers of butterflies, capturing them and sucking out their body fluids.

Numerous other enemies<sup>3</sup> attack this cabbage worm, and it is sometimes subject to a contagious bacterial disease<sup>4</sup> similar to that of the cabbage looper. It is, however, less susceptible to this malady, although in some seasons, for example, in 1916 in southern California, great numbers are destroyed by it.

Birds which are known to feed upon cabbage worms are the chipping sparrow, English sparrow, and house wren. It is certain, however, that other species eat them, and in one case it was found that during the winter the number of pupæ of the cabbage butterflies was reduced more than 90 per cent by birds feeding upon them.



FIG. 10.—An ambush-bug, *Phymata wolfii*, which preys on butterflies of the common cabbage worm: a, View from above; b, view from side; c, front leg; d, beak. a, b, Enlarged; c, d, more enlarged. (Riley.)

<sup>1</sup> *Pollistes metricus* Say, *pallipes* Lepel., et al.

<sup>2</sup> *Phymata wolfii* Stal.

<sup>3</sup> Among other predacious enemies observed in this country are the wheel bug (*Arilus cristatus* L.) and the armed soldier-bug (*Podisus maculiventris* Say). The cabbage worm is also parasitized by the tachina flies *Exorista vulgaris* Fall and *Frontina archipiprora* Will., as well as by *Sarcophaga* (*Boettcheria*) *latisterna* Parker. About 10 additional European parasites are listed.

<sup>4</sup> *Micrococcus pieridis* Burkill.

## METHODS OF CONTROL.

The imported cabbage worm is not difficult to control, and it should be borne in mind that most other "worms" will be controlled by the same methods, and that other cabbage pests are more often present than not.

### ARSENICALS.

Repeated experiments have shown that the best remedy is one of the arsenicals; and that arsenate of lead and Paris green are preferable to others in common use. If Paris green is used it may be applied either wet or dry, preferably, however, as a spray, at the rate of 1 pound to 50 gallons of water. The plants should be free from insect attack when they are set out, and should be sprayed a few days later to make sure that the poison reaches the young caterpillars before they have burrowed far into the heads. Other applications should follow as inspection of plants shows that they are necessary. These applications of arsenicals can be made with absolute safety until the heads are nearly formed, and, for that matter, even later, as the poison disappears from plants almost completely within two to three weeks after application, and even earlier in event of repeated or heavy rainfall. After the removal of the outer leaves, in preparation of the cabbages for market, and after other leaves have been picked off, as is done before the cabbages are cooked or cut up for salad, there is usually very little, if any, of the arsenic left.

### HARMLESSNESS OF ARSENICALS WHEN PROPERLY APPLIED.

Chemical analysis has shown that cabbage which has been sprayed or dusted with an arsenical as prescribed, and prepared for cooking in the usual manner a week later, has not even a trace of the arsenic remaining. The use of arsenicals against cabbage worms is almost universal in the United States, although growers are sometimes loath to acknowledge the fact for fear of the loss of customers who are not fully acquainted with the harmlessness of the remedy. There are no authentic recorded instances known to the writer of poisoning from the consumption of cabbage treated with an arsenical. It has been proved that 28 cabbage heads, dusted in the ordinary way with Paris green, would have to be eaten by an adult human at one meal before poisonous effects could be produced. The experience of a Virginia market gardener who dusted his cabbage with Paris green and flour, omitting to inform his family of the fact, should be cited. A day or two later he ate heartily of this cabbage, as did others, and afterwards was questioned by his wife as to the peculiar powdery substance on the heads. Although poisoning was anticipated, no ill results followed.

## ARSENATE OF LEAD.

As a result of the abnormal conditions incident to the European war, there is a scarcity of Paris green, which has naturally increased the cost. Arsenate of lead, however, which has been rapidly superseding Paris green and other arsenicals as an insecticide, has not increased proportionately in price, and for many reasons is preferable.

It has the advantage of being less harmful to growing plants and adheres better to the foliage, is less apt to burn the leaves of delicate plants, and is less troublesome to prepare. It serves the same purpose as Paris green and is applied in the same manner. It is sold both in paste and in dry powder form. Two pounds of dry lead arsenate to 50 gallons of water or Bordeaux mixture will make a solution of sufficient strength to destroy cabbage worms and similar insects. It may, indeed, be used as strong as 1 pound to 10 gallons of water on hardy plants without injury, but this is inadvisable because of the increased cost, the danger of scorching young plants, and the fact that, thus used, it is no more effective than the prescribed dose. The paste form must be used at double strength, or 4 pounds to 50 gallons of water. The number of sprayings to be applied depends on local and seasonal conditions. Sometimes a single spraying at the proper time will suffice, but usually two or three applications are necessary for cabbage worms which have more than one generation. The adhesiveness of the spray material is promoted by the addition of about the same amount by weight of resin-fishoil soap as of the arsenical used.

Arsenate of lead as a spray is valuable in that it leaves, on drying, a white coating on the plants, so that after spraying it can be determined readily which plants have been treated and which have not been reached.

Extensive experiments have proved that, for economy and efficiency, the best form of spraying machinery should be used. In regard to nozzles the "Vermorel," "cyclone," and "mistry" types are most effective as well as the most economical. When the arsenical is forced through a nozzle of this type the spray is mist-like in appearance and adheres to the foliage instead of forming small drops which quickly roll off the smooth leaves of cabbage plants. The best sprayer is the compressed-air type, constructed for use both by hand and by machinery, the latter to be driven by horsepower.

## POISONED-BRAN MASII.

A mixture of bran with Paris green, the standard remedy for cutworms and grasshoppers, is, according to the testimony of some who have used it, successful against "cabbage worms," and should be tested against the imported cabbage worm. Any arsenical can be

employed in the preparation of this mixture. It is best to mix the bran with the poison and sugar before adding the water. The proportions are 2 or 3 ounces of sugar or other sweetening, a teaspoonful of Paris green, and about 1 pound of bran, to a gallon of water; so as to make, when stirred, a mixture that will easily run through the fingers. In its application it is merely sprinkled, either wet or dry, over the affected plants.

#### THE HOT-WATER REMEDY.

As long ago as 1883, water at a temperature of about 130° F. was advised as a remedy for this cabbage "worm." It does practically no harm to the plants and kills all insects with which it comes in contact. It is scarcely applicable to large fields, however, on account of the difficulty of maintaining the proper temperature.

#### CONTACT POISONS.

Kerosene emulsion is not as effective as the arsenicals, because in its application it is necessary for the spray to come into direct contact with the larvæ or "worms" in order to kill them.

When strong soap solutions are used on ornamental plants infested by aphides or plant-lice and this species is also at work, such insects as are actually touched will be killed. Where the plants affected are attacked by thrips and other minute insects, and such contact poisons as nicotine sulphate are employed, these will also kill cabbage worms, but none of the poisons of this nature are standards for the chewing insects like the cabbage worms, and are not recommended except in the case of the occurrence of sucking insects on the same plants. A combination spray of an arsenical mixed with nicotine sulphate, kerosene emulsion, or soap is sometimes used with good effect to kill both aphides, or thrips, and cabbage worms.

#### PYRETHRUM.

Pyrethrum insect powder is not so useful as an arsenical. Of its effectiveness, Dr. James Fletcher, late entomologist of the Dominion of Canada, wrote that "diluted with four times its weight of common flour and then kept tightly closed for 24 hours (before use), it leaves nothing to be desired, and thousands of dollars are saved yearly to small growers, who most need assistance." Pyrethrum is rather costly, varies as to purity, and is said to discolor the leaves, but it has the advantage of being nonpoisonous to human beings and domestic animals. If used too sparingly a portion of the caterpillars are merely numbed and eventually recover. Younger caterpillars are more susceptible. It can not be recommended for use on large areas.

## HAND METHODS.

For the kitchen garden, hand picking is sometimes practiced, especially when plants are first set out. It is laborious, although effective if the work is carefully conducted.

## CLEAN FARMING AND TRAP CROPS.

If cooperation in clean methods of farming and in the use of arsenicals could be secured by any possibility, much of the loss due to the ravages of this pest might be averted. The practice of leaving cabbage stalks in the field after the main crop has been harvested is reprehensible. All remnants should be gathered and destroyed, with the exception of a few left at regular intervals through a field as lures to induce the female butterflies to deposit their eggs upon them. Such stalks, being useless, should, where feasible, be poisoned freely with arsenicals so that the last generation will have no place to develop in the fields.

## UTILIZATION OF NATURAL ENEMIES.

It is matter of common observation, frequently recorded, that two parasitic enemies of this species do excellent service in reducing the numbers of their host, viz, the cabbage-worm chalcis fly<sup>1</sup> and an ichneumon fly.<sup>2</sup> (See pp. 8-9.) The former issues from the chrysalides through minute holes in the dry outer skins. The latter issues from the caterpillars and forms masses of yellow cocoons. As soon as these cocoons are seen, all caterpillars that can be collected should be gathered carefully with portions of the leaves to which they are attached and transferred to barrels or large boxes, which should be covered with wire netting of a mesh which will permit the parasites to emerge but will prevent the butterflies from escaping. An ordinary screen mesh of 12 to the inch or coarse mosquito netting will answer this purpose. In addition, a few holes should be bored into the bottom of the barrel or box used for this purpose, small enough to prevent the caterpillars from escaping. This will permit rain water to drain off which might otherwise drown the insects.

## SUMMARY.

The imported cabbage worm is a velvety green caterpillar measuring about an inch and a fourth when full grown. It is the larva or young of a white butterfly. It begins work soon after young plants are set out, and in the case of cabbage riddles the outer leaves and bores into the heads. As a result entire crops are often lost.

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<sup>1</sup> *Pteromalus puparum*.

<sup>2</sup> *Apanteles glomeratus*.

It was introduced from Europe and has been known in the United States since 1865. It has become a most serious drawback to the cultivation of cabbage, cauliflower, turnip, and related crops in this country.

The first generation is produced on wild cruciferous plants, and the second attacks crop plants. It is capable in the warmest weather of developing from egg to adult or butterfly in 22 days. Even in its northernmost range it is triple-brooded, and southward there may be as many as six distinct generations.

Two natural enemies contribute considerably to the decrease of this species, otherwise it would be a pest of still greater severity.

The best remedies are the arsenicals, of which arsenate of lead and Paris green are the most efficient; the former, being cheaper at the present time, is recommended at the rate of 2 pounds in powder form or 4 pounds in paste form to 50 gallons of water. Adhesiveness is enhanced by the addition of about the same amount by weight of crude resin soap or resin-fishoil soap.

The best form of spraying machinery should be used, with special attention to nozzles in order to secure a mist-like spray.

The arsenicals are harmless when properly applied as directed.

In addition to the persistent use of arsenicals, clean farming should be pursued in cooperation with neighboring cabbage growers to obtain the best results.

It is advisable to encourage the parasites above-mentioned according to the directions given.

Finally, cooperation in the use of arsenate of lead as a spray and in maintaining clean farming and other methods is highly desirable in all communities. If this could be practiced on an experimental scale under proper supervision the results would soon be apparent. It must be kept up year after year, however, owing to the constant migration and invasion of this cabbage worm from other sources.

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